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Experiments: Anomalies and open issues of the MICROSCOPE Space Testof the Weak Equivalence Principle

MICROSCOPE's final results report no violation of the Weak Equivalence Principle (Universalityof Free Fall) for Pt and Ti test masses quantified by an E¨otv¨os parameter η~10−15, an improvementby about two orders of magnitude over the best ground tests. The measurement is limited byrandom noise with 1ν√ frequency dependence attributed to thermal noise from internal dampingoccurring in the grounding wires. From information available and the physics of internal damping wecalculate the differential acceleration noise spectral density at the signal frequency, and show it varieswidely between experiment sessions. Such large variations are inexplicable if translated into physicalquantities such as the quality factor. While calibrations interspersed with measurement sessionsmay cause some such changes, they cannot explain jumps between consecutive sessions withoutrecalibration. A potential explanation is conjectured related to a fluctuating zero depending onmeasurement initialization errors. The experiment was severely affected by "glitches"–anomalousacceleration spikes related to radiation from the Earth–injecting significant power at the signalfrequency and its harmonics. The procedure used to deal with the glitches depends on introducingartificial data and leaves spurious effects potentially mimicking a violation signal or canceling a realone. An alternative procedure, relying only on real measured data, is proposed, already used inground tests of the Weak Equivalence Principle by theE¨ot-Washgroup. Future experiments aimingto exploit the full potential of space must resolve these issues, rely solely on measured data, and,more generally, readdress the experiment design

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